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The Development of the Iron Industry in East Tennessee

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To the Graduate Council:

I am submitting herewith a thesis written by Alan Hersh entitled "The Development of the Iron Industry in East Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Geography.

Harold C. Amick, Major Professor

We have read this thesis and recommend its acceptance:

Lillian Stimson, Harry Klepser, Robert Long

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(Original signatures are on file with official student records.)

December 10, 1958

To the Graduate Council:

I am submitting herewith a thesis written by Alan Hersh entitled "The Development of the Iron Industry in East Tennessee." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Geography.

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THE DEVELOPMENT OF THE IRON INDUSTRY IN EAST TENNESSEE

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

---

by

Alan Hersh

December 1958

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TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
II.	PHYSICAL SETTING	2
	Location	2
	Geology and Physiography	2
	Blue Ridge Province	3
	Blue Ridge in Tennessee	3
	Ridge and Valley Province	5
	Ridge and Valley in East Tennessee	5
	The Appalachian Plateaus	7
	Cumberland Plateau	7
III.	GEOLOGY OF IRON ORE DEPOSITS	9
	Red Ores	9
	Tellico Iron Ore	10
	Rockwood Iron Ore	11
	Brown Ores	12
	Mountain Ores	13
	Valley Ores	13
	Magnetite	14
	Hematitic Magnetities	15
	Titaniferous Magnetites	15
	Non- Titaniferous Magnetite	16
IV.	THE IRON INDUSTRY, EARLY PERIOD: 1790-1860	17

CHAPTER PAGE

IV. (continued)

Nature of the Industry 17

Examplee of Areas of Development 21

Bumpass Cove 21

Shady Valley 26

Tellico Plains 27

Ducktown 27

Other Areas 28

V. THE IRON INDUSTRY, PEAK PERIOD: 1870-1910 29

Nature of the Industry 29

Areas of Development 32

Chattanooga 32

Rockwood 35

Dayton 36

Embreeville 37

Johnson City 38

Sequatchie Valley 40

Ducktown 41

Other Areas 42

VI. THE IRON INDUSTRY, RECESSION AFTER 1910 44

Nature of the Industry 44

Examples of Areas of Development 44

CHAPTER PAGE

LaFollette 45

Rockwood 46

Copper Hill 49

Mining Operations 49

VII. SUMMARY AND CONCLUSIONS 50

BIBLIOGRAPHY 52

APPENDIX 56

LIST OF TABLES

TABLE		PAGE
I.	East Tennessee Furnaces, 1854	22
II.	East Tennessee Bloomeries, 1854	23
III.	East Tennessee Refineries, 1854	24
IV.	Iron Production in Bumpass Cove, 1896-1933	39
V.	Iron Ore Production in Johnson County, 1903-1910	43

CHAPTER I

INTRODUCTION

Production of iron in East Tennessee began almost with the advent of the first settlers. From its early, almost primitive, beginnings, iron production developed into a large-scale, modern industry and then declined to the point of being almost non-existent.

The history of the iron industry can be divided into three phases; the early period of the late eighteenth and early nineteenth centuries; the period of large-scale development of the late nineteenth century and early twentieth century; and the period of decline of the twentieth century. Each period was distinctly different from the others. This study is concerned with the methods of production, sources of raw materials, markets, transportation facilities, areas of development, and the various other characteristics and problems of each period in an attempt to discover those factors which led to the rise and ultimate decline of the iron industry in East Tennessee.

CHAPTER II

PHYSICAL SETTING

Location

For the purpose of this study, East Tennessee is defined as that portion of the state lying between the Tennessee-North Carolina boundary on the east, and the western edge of Sequatchie Valley on the west. This area includes the following counties; Anderson, Bledsoe, Blount, Bradley, Campbell, Claiborne, Carter, Cocke, Cumberland, Grainger, Greene, Hancock, Hamilton, Hamblen, Hawkins, Jefferson, Johnson, Knox, Loudon, Marion, McMinn, Meigs, Monroe, Morgan, Polk, Rhea, Roane, Scott, Sevier, Sullivan, Unicoi, Union, Washington, and the eastern half of Sequatchie. With the exception of that portion of Sequatchie County included here, this area coincides with the Eastern Grand Division of Tennessee as laid forth in the Tennessee Code Annotated.[1]

Geology and Physiography

East Tennessee is composed of parts of three physiographic provinces, the Blue Ridge on the east, the Ridge and Valley, and the

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[1] Tennessee Code Annotated (Indianapolis: The Bobbs-Merril Company, Inc., 1955), Volume II, p. 209.

Cumberland Plateau section of the Appalach an Plateaus on the we t.

Blue Ridge Province

The Blue Ridge Province is a belt of mountains extending in a southwest direction from just south of the Susquehanna River in southern Pennsylvania to the vicinity of Mount Ogelthorp in northern Georgia. The province is bounded on the southeast by the Piedmont Province and on the northwest by the Ridge and Valley Province. Maximum width of the province is approximately seventy miles.[2]

The rocks of this province consist for the most part of Pre-Cambrian crystallines of very complex structure. The western front of the range is composed of Lower Cambrian Quartzites.[3]

Blue Ridge in Tennessee. The Blue Ridge Mountains or more properly the Unakas, occupy the extreme eastern portion of Tennessee, and extend for almost the entire length of the state in a northeast-southwest direction. The Tennessee-North Carolina boundary follows approximately the crest of these mountains and the highest elevations in the state are found here. Elevations of over 6,000 feet are common, and Clingman's Dome, 6,642 feet, the highest point in the state is located in the Blue Ridge.

As has already been mentioned, the rocks are predominantly

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[2]Nevin M. Fenneman, Physiography of the Eastern United States (New York; McGraw-Hill Book Company, Inc., 1938), p. 163.

[3]Ibid., p. 164.

Pre-Cambrian crystallines. The western boundary of the province is determined by the limit of overthrust of the strong metamorphosed rocks on the unaltered limestone of the Great Valley.[4]

The direction of the mountains is generally independent of structure, and linear ridges are confined to the belt of metamorphosed Cambrian rocks on the west. Chilhowee, Stone, Bald, Holston, and Iron Mountains belong to this group of linear ridges.

The mountains are generally classed as subdued with crags, bare cliffs, and talus slopes rare. Steep cliffs of bare rock are confined to newly deepened gorges. Summits are generally rounded, and domes are plentiful, but few mountains can be classified as peaks. Forests once covered almost all of the mountains, and still cover the highest mountains, although there are some grass-covered summits known as "balds" whose origin is unknown.[5]

The Holston, French Broad, Little Tennessee, Hiwassee, and other rivers rise in the Blue Ridge and flow westward to meet the Tennessee River.

A feature peculiar to the Blue Ridge in Tennessee is the coves on the northwest slopes of the mountains. These isolated, flat-floored mountain valleys range from 1,200 feet to 1,800 feet among mountains several thousand feet higher. These coves are known

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[4] Ibid., p. 173.

[5] Ibid., p. 174.

geologically as "fensters" (windows). The mountains were carved out of metamorphosed Cambrian or Pre-Cambrian conglomerate thrust over the limestone of the Valley. The thrust plane is so nearly horizontal that the overthrust block has been worn through to expose the limestone, which has been easily eroded to form the valleys. These coves have been termed cultural and economic, as well as geologic inliers of the Great Valley.[6]

Ridge and Valley Province

The Ridge and Valley Province extends from the St. Lawrence Valley to the Coastal Plain in Alabama, a distance of 1,200 miles. For most of its length, the province is bounded on the southeast by the Blue Ridge and on the northwest by the Appalachian Plateaus.[7]

Ridge and Valley in East Tennessee. The Ridge and Valley Province extends in a northeast-southwest direction the entire length of the state between the Blue Ridge on the southeast and the Cumberland Plateau on the northwest. The province averages about forty miles in width.

The rocks consist of folded and faulted Paleozoic sediments. The rocks have been closely folded and almost every fold is broken by a fault. Erosion of the weaker limestones and shales has formed

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[6]Ibid., p. 175.

[7]Ibid., p. 267.

the valleys, while the more resistant sandstones, conglomerates, and cherty rocks hold up the ridges. Valley land occupies more of the total land than do the ridges.

The province is in its second cycle of erosion. The original valleys and ridges formed by the warping of the strata have been eroded to a peneplain, and new valleys have been carved out of the peneplain, resulting in even-crested ridges.

The average altitude declines to the south, with the ridges being about 3,000 feet near the Tennessee-Virginia border, around 2,000 feet near Knoxville, and 1,000 feet at the Tennessee-Georgia border. Valley floors decline from 2,100 feet in southern Virginia to 1,200 feet around Knoxville and to about 800 feet at the Georgia boundary.[8]

The main ridges north of Knoxville are held up by the Clinch and related sandstones, with the lowlands on limestone and dolomite. Most of these ridges terminate north of Knoxville, and from there south the ridges are lower and the relief less. East of Knoxville, on Ordovician shales, are a series of rounded hills known as "The Knobs"

Drainage is to the south and west by way of the Tennessee River which is formed by the confluence of the Holston and French Broad Rivers at Knoxville. Most of the tributaries of the Tennessee

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[8] Ibid., p. 268 - 272.

rise in the Blue Ridge, with only a few small streams entering from the Cumberland Plateau.

The Appalachian Plateaus

To the west of the Ridge and Valley Province, and extending from southern New York State to northern Alabama, lie the Appalachian Plateaus.

Cumberland Plateau. The Cumberland Plateau is the name given to that portion of the Appalachian Plateaus within the state of Tennessee. The plateau lies to the west of the Ridge and Valley Province, and is separated from it by a 1,000 foot high escarpment. The surface of the plateau is around 2,000 feet in Tennessee.[9]

The rocks are essentially horizontal Upper Paleozoic (Mississippian and Pennsylvanian) sandstones and shales. Although Pennsylvanian sandstone forms the surface of the plateau, seventy-five percent of the rock is shale. Some coal is found in the plateau. The surface is rolling with some dissection by young stream valleys.

Sequatchie Valley, an anticlinal valley to the west of the Walden Ridge section of the plateau, was formed by the uparching and subsequent erosion of the sandstones. This breaching of the sandstone arch has exposed the weaker limestones and dolomites which have been

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[9] Ibid., pp. 333-339.

easily eroded. The floor of Sequatchie Valley is similar in every respect to the Ridge and Valley Province to the east. The Crab Orchard Mountains at the north end of Sequatchie Valley represent that portion of the sandstone arch which has not been breached, and they stand up in relief 1,000 feet above the plateau surface. Wills Creek Valley, near Chattanooga, is a feature similar to Sequatchie Valley, and separates Lookout Mountain from the main body of the plateau.

CHAPTER III

GEOLOGY OF IRON ORE DEPOSITS

Three varieties of iron ore occur in East Tennessee. These are "red" or hematite ores, "brown" or limonite ores, and magnetic ores.

Red Ores

The red ores are generally confined to the west side of the Ridge and Valley Province in East Tennessee to Sequatchie Valley. They occur at the base of the Cumberland Escarpment and in the ridges directly in front of it from Chattanooga to LaFollette, and in the escarpment on the east side of Sequatchie Valley.

Red ore is composed of red hematite, or anhydrous ferric oxide (Fe_2O_3), and a variety of impurities including silica (SiO_2), alumina (Al_2O_3), calcium carbonate ($CaCO_3$), magnesium carbonate ($MgCO_3$), sulpher, phosphorous, and manganese.[1]

The distinguishing characteristic of the red ore is that it occurs in beds, or thin, lenticular masses of great linear extent, interbedded with shale, limestone, and sandstone. Only three formations in East Tennessee contain sufficient concentrations of iron

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[1]Ernest F. Burchard, The Red Iron Ores of East Tennessee (Nashville: Tennessee Division of Geology, 1913), p. 48.

oxide to be classed as red ore-bearing formations. These are the Tellico sandstone (Ordovician), the "Rockwood" formation (Silurian), and the upper or Mississippian portion of the Grainger shale. Only the "Rockwood" formation contains ore of more than local importance.[2]

Tellico Iron Ore

Interbedded with the shale in the Tellico sandstone, there are in a few localities thin seams or lenses of hematite of slight extent. The ore varies from a ferruginous, calcareous sandstone to a rich, compact material, composed mainly of iron oxide, and of relatively high specific gravity. The richer beds range from a few inches to eighteen inches in thickness, and leaner beds are much thicker.

Deposits of economic importance may be formed when the Tellico sandstone has been weathered and the fragments of residual ore have been concentrated in basins on the surface of harder rocks.[3]

Given below are some analyses of iron ore from the Tellico formation.[a]

Locality	Fe	SiO_2	Al_2O_3	CaO	MgO	M	P	S	H_2O
Riceville	56.58	18.05	-	-	-	-	0.65	-	1.10
Sweetwater	46.90	20.16	20.16	-	-	2.12	-	-	-
Tuckahoe District	48.1	20.16	-	1.00	-	-	0.42	0.06	-

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[a]Source: Ernest F. Burchard, The Red Iron Ores of East Tennessee (Nashville: Tennessee Division of Geology, 1913), pp. 58, 93.

[2]Ibid., p. 49.

[3]Loc. cit.

"Rockwood" Iron Ore

A characteristic of the "Rockwood" ore is that when it is weathered the calcium carbonate is dissolved out and the content of iron oxide, silica, and other insolubles is increased proportinately. The resulting product is termed "soft ore", and is usually porous and friable when compared with the unaltered material, or "hard ore."

The "Rockwood" ore outcrops along the foot of the Cumberland Escarpment from the southern border of the state at Chattanooga to the northern border at Cumberland Gap and in several separate localities in the Valley. These outcrops are not continuous because in places a number of thrust faults have buried the formation below older rocks.[4]

Given below are the analyses of hard and soft ores from Chamberlain, Tennessee.

	1	2	3	4
SiO_2	5.00	7.92	7.63	7.62
Al_2O_3	2.82	3.07	3.64	4.31
Fe_2O_3	36.44	50.60	67.60	74.96
FeO	2.20	2.44	4.47	.10
MgO	1.63	1.71	.50	.47
CaO	24.84	13.77	1.68	.40
CO_2	19.89	12.29	3.04	.32

1. Hard ore, large lump, remote from line of division between hard and soft ore.
2. Semi-hard, small slab, near line of division between hard and soft ore.

(continuation of analyses on following page.)

[4] Ibid., pp. 75-81.

	1	2	3	4
Na_2O	.10	.10	.26	.12
K_2O	.22	.25	.33	.30
TiO_2	.11	.10	.26	.12
P_2O_5	.99	1.31	1.69	1.22
S	.05	.05	.07	.02
Mn	.30	.33	.58	.31
H_2O-	.89	.59	.84	.66
H_2O+	4.72	5.52	8.15	9.35
	100.20	100.05	100.29	100.60
Fe (From $FeO+Fe_2O_3$)	27.22	37.32	52.55	50.79

3. Soft, small slab, near line of division between hard and soft ore.

4. Soft ore, large lump, remote from line of division between hard and soft ore.

[a]Source: Ernest F. Burchard, The Red Iron Ores of East Tennessee (Nashville: Tennessee Division of Geology, 1913), p. 76.

Brown Ores

The brown ores are the most important ores in East Tennessee in terms of tonnage produced. Safford in 1856 termed reserves of the brown ores as "practically inexhaustable." They are confined to the eastern side of the Valley and to the coves along the western front of the Blue Ridge. The folding and faulting which gave rise to the Ridge and Valley Province produced conditions favorable to the rapid weathering of the rocks. These rocks, particularly the shales and some of the limestones, contain small quantities of iron minerals. During the process of weathering and erosion, the iron which had been

widely disseminated has been concentrated, where conditions were favorable, in the form of hydrated iron oxide to form deposits of brown ore. The brown ores are generally classified as two types, the mountain ores and the valley ores.[5]

Mountain Ores

These deposits draw their name from the fact that they always occur upon the sides or at the base of a sandstone, chert, or quartzite ridge. They are most extensively developed along the extreme eastern margin of the valley where the Cambrian quartzite forms a high ridge flanking the crystalline rocks of the mountains. The quartzite beds dip steeply to the west beneath the overlying shales and limestones, and the iron derived from the weathering of these shales and limestones is concentrated downward upon the impermeable quartzite. These deposits are very diverse, varying from fissure veins and replacements in the sandstone and shale, through blanket deposits on the quartzite, to irregular pockets scattered through the residual clay. This last type is the most common and most characteristic. It if difficult to determine the size of the deposits in advance of development, and tonnage estimates vary widely.

Valley Ores

These deposits are associated with limestone and dolomite formations. They are derived from minerals that were disseminated

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[5]C. W. Hayes, Iron Ores of the United States (Washington: United States Geological Survey, 1909), pp. 91-92.

through the rocks and have been concentrated during weathering and erosion. Their location depends on the abundance of iron in the original rocks and on favorable conditions for concentration. These deposits are always bedded in the residual mantle formed from the insoluble parts of the underlying rocks. They vary in form, but usually occur as concretions varying in size from those containing several tons down to those the size of a pea, disseminated through the residual clay.[6]

Given below are the analyses of three samples of brown ore taken from the Tellico Plains area.[a]

Sample	Iron Per Cent	Iron Per Cent	Iron Per Cent
1	37.9	28.27	tr.
2	40.2	27.5	0
3	43.1	23.2	tr.

[a]Source: Royal P. Jarvis, "The Valley and Mountain Ores of East Tennessee" Resources of Tennessee (Nashville: Tennessee Geological Survey, 1913), p. 336.

Magnetite

The magnetic ores of this region are located in Carter County in extreme northeast Tennessee and in Cranberry area of Avery County, North Carolina. Ore from the Cranberry mines was for many years sent

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[6]Loc. cit.

to the furnace at Johnson City, Tennessee, and this justifies its being mentioned in this study. The magnetic ores of this area are of three types; hematitic magnetites, titaniferous magnetites, and non-titaniferous magnetites.[7]

Hematitic Magnetites

The hematitic magnetites consist of small deposits scattered through the mountainous area of Tennessee and North Carolina. The largest and most characteristically developed deposits are in northeast Carter County, Tennessee on Lunsford Branch between Butler and Shell Creek. These hematitic magnetites are not considered of commercial importance because the deposits are too small to warrant the expenditure necessary to place them on the railroad.[8]

Titaniferous Magnetites

The titaniferous magnetites are found in the mountain area. Some of the deposits are large, but most are too small to be of any value as ore. So long as there is a sufficient supply of non-titaniferous magnetite available there will be no demand for the titaniferous magnetite as a source of iron.[9]

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[7] W. S. Bayley, The Magnetic Iron Ores of East Tennessee and Western North Carolina (Nashville: Tennessee Division of Geology, 1929), pp. 11-12

[8] Ibid., p. 12.

[9] Loc. cit.

Non-titaniferous Magnetite

There are some large deposits of non-titaniferous magnetite in the mountain district of North Carolina and Tennessee. The largest deposits occur in a belt passing through Cranberry in Avery County, North Carolina and extending into Carter County, Tennessee. The famous Cranberry Mine is located in this belt. The non-titaniferous ores are regarded as the most promising sources of iron in this district. They are low in phosphorous, sulphur, and titanium, and have consequently been used in the making of low-phosphorous iron at the Johnson City Furnace.[10]

[10] Ibid., p. 14.

CHAPTER IV

THE IRON INDUSTRY, EARLY PERIOD: 1790-1860

Nature of the Industry

The beginning of iron production in East Tennessee is practically coincident with the settlement of the state. Production began soon after settlement and rapidly increased in importance. A number of factors contributed to this. Among these are:

1. The long distance of the settlements from the iron producing and importing centers of the east and the consequent high price of the iron brought into the area;
2. The side distribution and ease with which the iron deposits could be worked;
3. The cheap and abundant supply of water power, charcoal, and labor;[1]
4. The ease with which iron products could be shipped by river to Cairo, New Orleans, and other points downstream.[2]

The result was that every county, and almost every cove and valley,

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[1]Royal P. Jarvis, "The Valley and Mountain Ores of East Tennessee", Resources of Tennessee (Nashville: Tennessee Geological Survey, 1913), p. 334.

[2]Earl C. Case, The Valley of East Tennessee, The Adjustment of Industry to Natural Environment (Nashville: Tennessee Division of Geology, 1925), pp. 56-57.

had a forge, blast furnace, or bloomery.

James King is given credit for having built the first iron furnace, which was erected on Steele's Creek in Sullivan County in 1784. David Ross built a blast furnace on the north fork of the Holston River in Hawkins County in 1789 or 1790.[3] A bloomery was built at Emeryville in Washington County in 1790, and other furnaces were built in East Tennessee in 1795 and 1797.[4]

The early iron industry in East Tennessee was primarily designed to meet the requirements of local areas. Furnaces and forges were usually operated as part of a combination of enterprises under one management which included iron works, grist mills, and saw mills.[5] In the early years, and for a long time afterward, production of metallic iron followed two methods. The simpler and more widely used method was the small forge or bloomery. The ore was heated in a charcoal fire to a white-hot, plastic mass and then lifted directly to an anvil where the slag and other impurities were driven out by a water driven heavy hammer. Repeated heating and hammering produced a very serviceable form of wrought iron which was usually drawn into

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[3]Joseph H. Clark, "History of the Knoxville Iron Company" (Unpublished M. A. thesis, Department of Economics, The University of Tennessee, 1949), pp. 4-5.

[4]H. H. Chapman, The Iron and Steel Industries of the South (University, Alabama: University of Alabama, 1953), p. 99.

[5]Loc. cit.

bars and sold to blacksmiths and farmers for conversion into horseshoes, plowpoints, nails, wagon tires, harrow teeth, and hoes.

The second method used a furnace, usually built of native stone, which produced cast iron. Iron ore, limestone, and charcoal were mixed, and poured into the furnace and ignited. A blast of air came from a bellows, operated by hand at first, and later by water power. The limestone served as a flux, and the melted iron flowed out the bottom of the furnace and was run into pigs or cast directly into pots, grates, andirons, stoves, or other articles needed in the frontier home. At the refinery forge the pigs of iron could be heated and hammered by the same type of tilt-hammers used at the bloomeries and converted into wrought iron. Around 1820, crude rolling mills were erected and were used in rolling wrought iron into strips or plates suitable for the manufacture of cut nails.[6]

Charcoal was the fuel used in the making of iron, and it was of utmost importance. In 1809, the Tennessee legislature showed its interest in encouraging the local production of iron by providing for the condemnation of public lands for the use of iron works. It was not necessary that mineral deposits be located on the land in question, the main purpose being to provide an abundance of wood for the manufacture of the charcoal.[7] Mr. E. Embree made the following statement

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[6] Paul M. Fink, "The Bumpass Cove Mines and Embreeville," East Tennessee Historical Society Publications, 16:50, 1944.

[7] Ibid., p. 51.

on his operations on Bumpers Creek (sic) in Washington County in 1840:

> To keep a smelting furnace in operation making about twenty tons of metal per week, requires 7,000 to 10,000 acres of common mountain land, such as is found uncultivated along the Unaka and Smoky mountains. This amount of land will reproduce the wood so as to keep up a constant supply.[8]

It is no wonder that so much of the virgin forest of East Tennessee was destroyed during this period.

Although the early iron industry was limited to local markets by the poor conditions of wagon trails and the lack of railroads, some iron was transported by river. As early as 1791, David Ross was shipping iron and iron products by water as far as Natchez and New Orleans.[9] James King also shipped iron and iron products from Long Island Boatyard (now Kingsport) to Natchez and New Orleans.[10] Boats of twenty-five tons were built at the large furnace at the junction of the two forks of the Holston, and these boats transported iron and castings, along with other produce to New Orleans. In the early 1820's, iron was manufactured near Rockwood and was

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[8]Gerard Troost, Fifth Geological Report of the State of Tennessee (Nashville: Tennessee Geological Survey, 1840), p. 37.

[9]Joseph H. Clark, op. cit., p. 5.

[10]Fink, op. cit., p. 49.

shipped by canoe to places down the Tennessee River. In 1838, flat-boats were used to ship iron to cities in Alabama, and in 1849, iron was shipped by river from Rockwood to St. Louis.[11]

The importance of iron to the early settlers can be seen in the fact that iron bar was used as a medium of exchange in Johnson and Carter Counties. It was used in local stores as currency and was later shipped to Knoxville, Bristol, and other places offering a market.

The iron industry probably reached its maximum distribution (but not necessarily its maximum production) prior to the Civil War. (See TABLE I, TABLE II, and TABLE III.)

Examples of Areas of Development

Bumpass Cove

Bumpass Cove is located in Unicoi and Washington Counties in northeast Tennessee. The iron deposits here consist of limonite in the residual clay of the Shady dolomite.[12]

According to local tradition iron was first mined in Bumpass Cove during the Revolutionary War by John Sevier.[13] In 1808, Elijah

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[11]Case, op. cit., p. 57.

[12]John Rodgers, Geology and Mineral Deposits of Bumpass Cove, Unicoi and Washington Counties, Tennessee (Nashville: Tennessee Division of Geology, 1948), p. 40.

[13]Ibid., p. 42.

TABLE I

EAST TENNESSEE FURNACES, 1854[a]

Name	County	Products, 1854		
		Pig Metal and Castings (tons)	Castings Alone (tons)	Ore
		Eastern Iron Region		
Union	Carter	250	-	Brown
O'Brien's	Carter	Out of blast since 1840		
Bushong's	Sullivan	105	25	Red
Welcker's	Sullivan	-	-	Red
Pleasant Valley	Washington	700	100	Brown
Clark's Creek	Washington	Out of blast since 1844	-	
Bright Hope	Greene	Out of blast for several years		
Tellico	Monroe	730	-	Brown
Ball Play	Monroe	70	-	Brown
		Dyestone Region		
Cumberland Gap	Claiborne	238	38	Dyestone
Crockett's	Claiborne	-	-	Dyestone
Sharp's	Grainger	In repair	-	Brown
Eagle*	Roane	930	-	Dyestone
Bluff*	Hamilton	New, capacity ten tons a day		Dyestone

[a]Source: James M. Safford, A Geological Reconnaissance of the State of Tennessee (Nashville: Tennessee Geological Survey, 1856), p. 51.

*Blast created by steam power, all other water. One ton - 2,268 pounds.

TABLE II

EAST TENNESSEE BLOOMERIES, 1854[a]

County	No. of Forges	No. of Fires	1854	
			Fires Used	Tons of Bar Iron Made*
Eastern Iron Region				
Johnson	14	26	26	367
Carter	5	10	10	168
Sullivan	2	4	4	30
Washington	2	4	4	55
Greene	6	9	7	95
Sevier	1	1	1	2
Blount	1	1	1	12
McMinn	1	1	1	13
Dyestone Region				
Hancock	1	1	-	-
Claiborne	3	5	4	90
Campbell	5	10	5	105
Anderson	?	?	-	-
Roane	1	1	1	7
Rhea	5	10	10	55
Total	47	83	74	999

[a]Source: James M. Safford, A Geological Reconnaissance of the State of Tennessee (Nashville: Tennessee Geological Survey, 1856), p. 51.

*2,240 pounds to the ton.

TABLE III

EAST TENNESSEE REFINERIES, 1854[a]

County	Forges	Fires	1854		
			Fires Used	Tons of Blooms Made*	Tons of Bar Iron#
Carter	3	5	2	-	20
Sullivan	2	8	6	-	75
Washington	1	5	5	480	-
Monroe	1	2	2	-	75
Total	7	20	15	480	170

[a]Source: James M. Safford, A Geological Reconnaissance of the State of Tennessee (Nashville: Tennessee Geological Survey, 1856), p. 55.

*2,464 pounds to the ton.

#2,240 pounds to the ton.

Embree purchased a bloomery and began operations in the cove. Embree built a new furnace at the mouth of Red Cut Hollow in 1812, and at the same time, built a rolling mill and machine for making cut nails at the riffle in the Nolichucky River about a mile below the present site of Embreeville. In the 1830's, a furnace was built on Clark Creek at the mouth of Furnace Stack Hollow, just across the divide from the head of Bumpass Cove. Ore was brought in wagons from the West Ore Bank in Bumpass Cove. Sometimes, to save a part of the long haul, the ore was dumped out of the wagons at the top of the ridge and allowed to roll down to the foot of the slope where it was reloaded and carted to the furnace. The furnace went out of blast in 1844. Later, a large furnace was built at the riffle in the Nolichucky and ore was barged down the river from the cove. In 1854, the ironworks on the Nolichucky were the most important in northeast Tennessee, and during the Civil War were an important source of iron for the Confederate States. After the war, the furnace was operated for a few years in the 1870's and was then abandoned.[14]

Shady Valley

The Shady Valley district is in northwestern Johnson County. Iron, in the form of limonite, occurs in the residual clay of the Shady dolomite. The earliest attempts to mine iron in Shady Valley

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[14]Fink, op. cit., pp. 52-53.

occured around 1790. No records of iron production are available, but evidently it was not great, though the iron was of good quality. Most of the iron went into the making of agricultural implements and other local uses.[15] Killebrew, in 1881, reported that iron from Shady Valley was being transported to Bristol and Abingdon to be made into gun barrels.[16]

Mountain City

The Mountain City district is in northeastern Johnson County, separated from Shady Valley by Iron Mountain. Deposits of brown iron occur in the residual clay of the Shady and Rome formations. The early mining in this district, as elsewhere in East Tennessee, was on a small scale, and the products were sold in local markets. Safford reports that in 1854 there were fourteen forges in Johnson County and that 367 tons of bar iron were made. Local residents report that four forges and a number of furnaces were operated at Laurel Bloomery in the northwest part of the Mountain City district.[17]

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[15]Philip King et al, Geology and Manganese Deposits of Northeastern Tennessee (Nashville: Tennessee Division of Geology, 1944), pp. 75-76.

[16]Joseph B. Killebrew, Iron and Coal of Tennessee (Nashville: Tavel and Howell, 1881), p. 15.

[17]King, op. cit., p. 115.

Tellico Plains

Tellico Plains is located in Monroe County in southeast Tennessee. The iron deposits here are all limonite.[18] Furnaces and bloomeries, supplied with ore from banks south of the town, were in operation in Tellico Plains before the Civil War. Car wheels produced here in 1851 - 53 were reported to be still in use in 1877. Killebrew reports that because of the superior quality of the iron, the Confederate government attempted to establish an armory here, but were prevented from doing so by the war.[19]

Ducktown

The Ducktown district, located in Polk County in extreme southeastern Tennessee, though more famous for its copper and sulphide deposits, was prospected for iron in the early days. In 1847, a furnace was built to make iron from the gossan ores. The operation was not a success because of the brittleness of the iron produced. The ore was obtained not far from the black copper horizon and was thus more cupriferous than the average gossan ores. A little iron was smelted during the Civil War, but production continued to be small until the building of the railroad.[20] This will be discussed in the

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[18]Jarvis, op. cit., p. 351.

[19]Joseph B. Killebrew, Report of the Bureau of Agriculture, Statistics, and Mines (Nashville: 1877), p. 177.

[20]W. H. Emmons and F. B. Laney, Geology and Ore Deposits of the Ducktown Mining District, Tennessee (Washington: United States Geological Survey, 1926), pp. 30-31.

following chapter.

Other Areas

The Stony Creek district in northeastern Carter County produced iron on a small scale from the "mountain ores" of the Erwin and other formations of the basal clastic group and from the "valley ores" of the Shady dolomite residuum. The product was sold in the local market for wagon tires and farm implements.[21]

Sevier County had two centers of iron production, one at Pigeon Forge, six miles south of Sevierville, and the other near the head of Dunn's Creek fifteen miles east of Sevierville. The ore for the forges at Pigeon Forge was obtained from small banks along what is now Ridge Road between Sevierville and Pigeon Forge and in part from Ware's Cove. On Dunn's Creek, a small charcoal furnace was operated around 1838. The furnace was forced to close because of the high manganese content of the ore.

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[21]King et al, op. cit., p. 179.

CHAPTER V

THE IRON INDUSTRY, PEAK PERIOD: 1870-1910

Nature of the Industry

Many iron furnaces were destroyed during the Civil War and were never rebuilt, partly because mine owners anticipated a quicker return on their investment from shipping ore to northern furnaces. This practice started about 1872 and continued for three years. During this brief period considerable amounts of ore from Tennessee as well as Alabama and Georgia were delivered to furnaces in Indiana and on the Ohio River.[1]

The southern ores were not adapted to the production of Bessemer pig, and consequently their market was limited. This, coupled with the presence of cheap and abundant fuel in the immediate vicinity of the mines soon caused the practice of shipping ore north to cease.[2]

The conversion from charcoal to coke as a fuel gave impetus to the rapid growth of the iron industry in East Tennessee and elsewhere

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[1]Victor S. Clark, History of Manufactures in the United States (New York: McGraw-Hill Book Company, Inc., 1929), p. 63.

[2]Ibid., p. 64.

in the South. The first pig-iron produced in the South using coke as the fuel was produced in 1867 by the Roane Iron Company at Rockwood, Tennessee. In the 1870's, coal of the Chattanooga area was found to be suitable for coking, and Chattanooga, a manufacturing town of some importance before the Civil War, became an iron-making center when, in 1874, the furnace of the Chattanooga Iron Company went into blast. Other furnaces and iron works were established nearby, and by 1877, Chattanoogans were referring to their city as the "Pittsburgh of the South." By 1885, there were nine furnaces and seventeen foundries and machine shops in the Chattanooga area.[3]

The new iron industry had little connection with the earlier charcoal furnaces. The many small forges and furnaces on the east side of the Valley gave way to a few modern blast furnaces and foundries on the west side of the Valley. The new industry was attracted to the more certain deposits of red iron ore and to the coal fields of the Cumberland Plateau.[4]

The growth of the industry was not steady. It was adversely affected by depressions, shortages of raw materials, labor problems, transportation difficulties, fluctuations in the market, inadequate capital, inefficient management, and competition from Northern iron

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[3]H. H. Chapman, The Iron and Steel Industries of the South (University, Alabama: University of Alabama, 1953), p. 102.

[4]Earl C. Case, The Valley of East Tennessee, The Adjustment of Industry to Natural Environment (Nashville: Tennessee Division of Geology, 1925), p. 57.

manufacturers. At other times the industry expanded due to increased demand, discovery of new iron and coal deposits, improved manufacturing methods, influx of capital from local, Northern, and foreign sources, better management, and development of markets.[5]

A limited market was the main problem of the industry. The high phosphorous content made southern ores unsuitable for the Bessemer Process of steel making, and manufacturers were limited to making high-phosphorous pig-iron. This found a market in the North until northern manufacturers started adding phosphorous to their furnace burdens. In 1883, a prominent Alabama producer said,

> You can go into the history of iron making in Alabama for the past twelve years and find it strewn with the wrecks of shattered hopes of men who built or leased furnaces.... Those of Tennessee have not fared much, if any, better, even when backed by millions of English capital and the skilled management from that country.... The great trouble is, we do not have home markets.... We depend entirely on the North and great West to keep our furnaces going.[6]

From 1898 until 1907, the Southern pig-iron industry enjoyed a period of prosperity, and many new plants were built throughout the South requiring the product of the furnaces.[7] In 1908, there were sixty-seven iron mines being worked and seventeen furnaces in operation in Tennessee.[8]

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[5]J. H. Clark, op. cit., p.7.

[6]Chapman, op. cit., p. 103.

[7]Morrow Chamberlain, A Brief History of the Pig Iron Industry of East Tennessee (Chattanooga: Morrow Chamberlain, 1942), p. 4.

[8]George H. Ashley, A Brief Summary of the Resources of Tennessee (Nashville: Tennessee Geological Survey, 1911), p. 32.

The iron industry played a significant part in the economy of East Tennessee during this period. In 1908, there were 3,800 men employed at iron mines and furnaces and approximately one and one-half million dollars in wages were paid. These figures do not include people employed at coal mines, limestone quarries, coke ovens, or on the railroads. These activities relied on the iron industry as did local merchants and other people not directly concerned with the industry but never the less dependent upon it.

Examples of Areas of Development

Chattanooga

In 1864, the Union Army built a rolling mill at Chattanooga on the Tennessee River for the purpose of re-rolling iron rail and producing bar iron for the Army. At the end of the war, the mill was sold to private interests, and in 1870, merged with the Roane Iron Company, and operated until 1877, when steel rails replaced iron and the mill was closed.

The first steel made in the South was made here. Two ten ton acid open-hearth furnaces were built in an attempt to hold the Southern trade, but a drop in market prices and the high cost of high grade ore forced a shutdown. Low phosphorous ore from Cranberry, North Carolina and Cartersville, Georgia together with scrap were used, but this proved unsatisfactory and uneconomical. Great difficulty

was encountered in keeping the phosphorous content within the Bessemer specifications for steel. About 50,000 tons of steel rail were produced. In 1886, a five ton Bessemer converter was installed. The first Bessemer steel in the South, using special low phosphorous pig-iron from the Rockwood and Citico furnaces made from Cranberry ore mixed with pig-iron imported from England, was made here on May, 1887. Because of the high price of rail at the time, this venture proved profitable until another drop in the market forced the cessation of this operation. In 1889, the property was sold to the Southern Iron Company. Two ten ton basic open hearth furnaces were installed, and on September 15, 1890, the first basic steel made in the South was produced. The operation proved unsuccessful, and the plant was closed in 1891.[9]

In 1874, the Chattanooga furnace with a daily capacity of twenty-five tons was built on the Tennessee River in West Chattanooga. The furnace was to manufacture pig-iron for conversion to Bessemer steel. Ore was obtained from North Alabama, North Georgia, and nearby deposits. The operation was small, employing only twenty-six men in 1878.

The production of this special pig-iron soon proved to be impractical due to the scarcity of pure ores. In 1885, a new furnace

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[9]Chamberlain, op. cit., pp. 7-8.

of eighty tons daily capacity, for the production of high phosphorous foundry pig-iron, was built on the same site.

The furnace was operated intermittently between 1895 and 1911 with most of its product being shipped to local foundries. The high delivered cost of ore, coke, and limestone, kept profits down. In 1911, a modern furnace of 200 tons daily capacity was built, ore and coal mines were developed using efficient mining equipment, and new coke-ovens were built in an attempt to produce iron at lower cost. The furnace operated until 1919, when the post-war depression forced its closing. The furnace was sold and scrapped in 1928.[10]

The Citico Furnace Company was incorporated in November, 1882, and the furnace was blown in in April, 1884. Coke, iron, and limestone were purchased from companies within a radius of less than 100 miles. The coke ovens were located at Soddy, Tennessee and in Sequatchie and Marion Counties, Tennessee and Dade and Walker Counties, Georgia. Red ore was barged down the Tennessee River from mines in Roane and Rhea Counties, Tennessee, and brown ore was shipped by rail from North Georgia and North Alabama. After a few years, river transportation was discontinued because the frequent handling of the ore proved more expensive than rail transportation. Most of the product of the

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[10] Ibid., pp. 15-16.

furnace was consumed locally.[11] Increased costs of raw materials and inability to compete with the Birmingham producers forced the furnace to be closed in 1911.

Rockwood

The first furnace was put in blast at Rockwood in 1868. This furnace produced 4,270 tons of pig-iron in 1869. The ore used here was red ore mined at the foot of Walden Ridge. A narrow-guage railroad was constructed from the furnace to Rockwood Landing on the Tennessee River, and the iron was hauled to the river and shipped by steamboat and barge to Knoxville and Chattanooga where rail connections provided for shipment to more distant points. The completion of the Cincinnati-Southern Railroad in 1880 gave access to markets in the North, East, and West.

The high phosphorous content of the Rockwood pig-iron was desirable in such things as stove plate, pipe, and machine parts. When mixed with low phosphorous Northern pig-iron, highly satisfactory castings were produced. Favorable freight rates were also advantageous, and for over sixty years, Rockwood pig-iron enjoyed a large market in the North, East, and West.

In 1901, two modern furnaces of over 200 tons daily capacity were erected. Except for temporary shutdowns, one or two furnaces was

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[11] Ibid., pp. 20-21.

in continuous operation from 1868 until 1930. In 1904 and 1905, the company developed its Chamberlain and Barnardsville iron deposits south of the Tennessee River. Between 1903 and 1920, it became necessary to purchase brown ores from Georgia and Alabama to keep the furnaces in full blast.[12]

Dayton

In 1884, a group of Scottish industrialists purchased coal, timber, and iron land on Walden Ridge and formed the Dayton Coal and Iron Company. Two modern blast furnaces of 72,000 tons annual capacity were built at Dayton on the Cincinnati-Southern Railroad. The operation had the same general layout as the plant at Rockwood, with the coal and iron mines lying in Walden Ridge to the west and the beehive coke ovens conveniently situated to both the mines and the furnace. High phosphorous foundry pig-iron was produced and was sent to Northern, Eastern, and Western foundries. Within a few months, it was found that sufficient ore could not be mined at this location, and the company was forced to purchase brown ore from North Georgia and North Alabama producers and red ore from the Roane Iron Company in Rockwood.

With the exception of the depression years of 1892 and 1897,

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[12]Ibid., pp. 8-9.

the operation was run profitably until 1910. In 1912, however, the ore contract with the Roane Iron Company expired and was not renewed because of that company's increased need for ore. The Dayton company attempted to develop red ore properties at Crescent near the Tennessee River. The cost of mining and transportation raised the cost of production, and this, coupled with low iron prices forced the company into receivorship in 1914. Production was never resumed, and the furnace was finally scrapped in 1934.[13]

Embreeville

In 1889, an English group, the Embreeville Freehold, Land, Iron, and Railway Company, Ltd. purchased large acreages of timber and mineral land in Bumpass Cove.[14] A city was laid out on the present site of Embreeville, and in 1890, a branch of the Southern Railroad was built from Johnson City to Embreeville.[15] In 1892, a furnace of 45,000 tons annual capacity was built and blown in. Foundry pig-iron was produced from the brown ores on the company's property. The operation proved unprofitable and was suspended after a year. The

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[13] Ibid., pp. 22-23.

[14] Rodgers, op. cit., p. 42.

[15] Guy R. Johnson, "The Embreeville Estate," American Institute of Mining Engineers Transactions, 26:141-142, 1896.

company went out of business during the panic of 1893 and the furnace was shut down.

George B. Parker, of London, England purchased the property in 1895 and resumed operations. The furnace was operated by a succession of owners during periods of high pig-iron prices until 1913 when high costs and depletion of the ore deposits forced the furnace to be permanently shut down. The furnace was scrapped in 1917.

Coke for the Embreeville furnace was supplied by the Pocahontas mines in Virginia and was shipped 200 miles by rail. Most of the product of the furnace was marketed in the West at foundries which needed a strong special iron.

Some iron was produced in Bumpass Cove in 1915 and 1918 as a by-product of zinc mining. This iron was not smelted at the Embreeville furnace, however, but was shipped to other furnaces.[16] (See TABLE IV for iron production in Bumpass Cove between 1896 and 1933.)

Johnson City

Construction was begun in 1892 at Johnson City on a blast furnace of 36,000 tons annual capacity designed to produce low phosphorous pig-iron to be marketed as "Special Bessemer." The furnace was to make use of the low phosphorous ores of Cranberry, North Carolina.

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[16] Rodgers, op. cit., p. 44.

TABLE IV

IRON PRODUCTION IN BUMPASS COVE, 1896-1933[a]

Year	Iron Concentrates (Long Tons)	Year	Iron Concentrates (Long Tons)
1896	67,000	1907	58,726
1897	90,000	1908	21,225
1898	61,500	1909	7,882
1899	56,721	1915	2,167*
1900	27,108	1916	3,501*
1904	2,002	1917	1,412*
1905	40,907	1918	218*
1906	52,912	1933	37*
		Total	493,318

[a]Source: John Rodgers, Geology and Mineral Deposits of Bumpass Cove, Unicoi and Washington Counties, Tennessee (Nashville: Tennessee Division of Geology, 1948), p. 46.

*By-product of other mining.

A narrow guage railroad, the East Tennessee and Western North Carolina Railway, was built from Johnson City to the mines at Cranberry, twenty-seven miles to the east.

The depression of 1892 forced a stoppage of work. In 1903, however, the owners of the Cranberry Mines and the railroad purchased the furnace and operated it during periods of favorable market conditions until 1919. The reason given for closing the furnace was that the crucible method of eliminating phosphorous, developed and used in the North, deprived the company of the larger portion of its market. The furnace was scrapped in 1921.[17]

Sequatchie Valley

In 1879, in anticipation of the completion of the Memphis and Charleston Railway to Chattanooga and the opening of navigation on the Tennessee River, construction was begun on two blast furnaces at South Pittsburg, Tennessee by a group of British capitalists who called themselves the Southern States Coal, Iron, and Land Company, Ltd. The first furnace, one of seventy tons daily capacity, was blown in in May, 1879. The second furnace, a somewhat larger one, was blown in about a year later.[18]

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[17] Chamberlain, op. cit., p. 25.

[18] Ibid., p. 17.

In December, 1881, the Tennessee, Iron, and Railroad Company took over the property of the British Company. The property consisted of the two furnaces at South Pittsburg, each now of 200 tons daily capacity, 105 beehive coke ovens at Victoria, Tennessee, two coal mines, a partially developed iron mine at Inman, Tennessee, and a large acreage of land in East Tennessee.[19]

A third furnace was completed at South Pittsburg in 1888, and at least one of the furnaces was in operation until October 17, 1905 when the furnace plant was shut down. The Tennessee Coal, Iron, and Railroad Company had become a large producer of iron and steel in the Birmingham area, where its deposits of iron ore and coal could be mined much cheaper and were of superior quality to those in Tennessee.[20]

Ducktown

In the early 1890's, the Loudon Iron and Coal Company shipped considerable amounts of iron ore to furnaces in Virginia and Tennessee. The panic of 1893, forced iron prices to drop and operations were suspended. In 1894, the Virginia Iron, Coal, and Coke Company began ore shipments. Operations continued until 1907 and about 750,000 tons of ore were mined. The ore was higher in iron than other southern ores and was very low in phosphorous. It had a ready market, as it was mixed with other ores to bring the mixture into Bessemer specifications.

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[19]Robert Gregg, Origin and Development of the Tennessee Coal, Iron, and Railroad Company (New York: The Newcomen Society of England, American Branch, 1948), p. 14.

[20]Chamberlain, op. cit., p. 18.

No gossan ore has been shipped from Ducktown since 1907.[21]

Other Areas

Between 1903 and 1910, large scale iron mining was carried on in the Mountain City district in northwest Johnson County by the Virginia Iron, Coal, and Coke Company and by other firms. There were nine or more mines in operation in the area during this period.[22] (See TABLE V.)

There has been no production in Johnson County since 1910.

The Knoxville Car Wheel Company mined ore on a large scale in the Stony Creek district of Carter County and operated a furnace near Carter between 1880 and 1900. The Virginia Iron, Coal, and Coke Company operated mines in the area between 1900 and 1907 and took out approximately 1,000 tons of iron ore a year.[23]

There were also small mining operations around Hampton in Carter County and Unicoi in Unicoi County before the First World War. A large amount of brown ore was also mined in the Del Rio district of Cocke County in the late 1800's and early 1900's.[24]

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[21]W. H. Emmons and F. B. Laney, Geology and Ore Deposits of the Ducktown Mining District, Tennessee (Washington: United States Geological Survey, 1926), p. 31.

[22]King et. al, op. cit., p. 115.

[23]Ibid., p. 176.

[24]H. W. Ferguson and W. B. Jewell, Geology and Barite Deposits of the Del Rio District, Cocke County, Tennessee (Nashville, Tennessee Division of Geology, 1951), p. 226.

TABLE V

IRON ORE PRODUCTION IN JOHNSON COUNTY, 1903-1910[a]

Year	Long Tons	Year	Long Tons
1903	17,845	1908	50,639
1904-1905	none reported	1909	47,602
1906	39,699	1910	6,867
		Total	221,837

[a]Source: King, Philip, Ferguson, Herman W., Craig, Lawrence C. and Rodgers, John. "Geology and Manganese Deposits of Northeastern Tennessee," Bulletin 52. Nashville: Tennessee Division of Geology, 1944.

CHAPTER VI

THE IRON INDUSTRY: RECESSION AFTER 1910

Nature of the Industry

The iron industry in East Tennessee underwent a sharp decline in the years just before and after World War I. Uncertain market conditions coupled with the inability of producers to obtain good quality iron ore and coal in sufficient quantities forced many operations to be suspended.

Between 1908 and 1915, pig-iron prices underwent sudden variations and producers experienced alternating periods of profit and loss. During World War I, pig-iron prices were high, but high federal taxes greatly reduced net profits. The post-war economic adjustment of 1919-1921 inflicted financial hardships on many companies.

Depletion of good quality ore deposits close at hand forced producers to obtain their ore from other areas, thus increasing the cost of production. East Tennessee producers, consequently, could operate successfully only during periods of high pig-iron prices.

Examples of Areas of Development

Most of the companies that went out of business during this

period have been discussed in the preceding chapter, and only those companies which continued operations will be discussed here.

LaFollette

The LaFollette Coal, Iron, and Railway Company erected a blast furnace of 175 tons daily capacity at LaFollette, Campbell County, Tennessee in 1901. Iron and coal mines were opened and coke ovens built nearby. This was the last furnace built in East Tennessee.

Between 1901 and 1909, operations were financially unsuccessful. In that year, the furnace, ore mines, and coke ovens were leased to the LaFollette Iron Company, with the holding company retaining the coal mines and selling coal to the leasing company. High phosphorous foundry iron was produced for shipment to Northern, Eastern, and Mid-western foundries.

Low pig-iron prices resulted in losses to both the iron company and the coal company, and both were forced into receivership, the coal company in 1913 and the iron company in 1915.

The LaFollette Coal and Iron Company purchased the property from the receivers, and operated it with satisfactory profit during the period of high pig-iron prices during World War I. The post-war depression of 1921 made profitable operations impossible and the furnace was permanently closed in 1924, but not completely scrapped until 1937.

The failure of the LaFollette operation can be attributed to the inferior quality and irregularity of the local ore and coal veins. About sixty percent of the ore used at LaFollette was obtained from brown ore mining companies in North Georgia, North Alabama, and Western North Carolina. The distance involved and the freight charges made the delivered price of this ore high. During the last months of operation, an attempt was made to use magnetite ore imported from Sweden, but this too proved financially impractical.[1]

Rockwood

The early history of the Rockwood operation has been discussed in the preceeding chapter.

Following World War I, freight rates to the East, North, and West were advanced, and this, consequently, increased the delivered cost of Rockwood iron. The demand for East Tennessee pig-iron was further reduced by the practice of Northern producers of using phosphate rock in furnace mixtures to produce high phosphorous foundry iron of similar analysis to the Rockwood iron. The demand for Rockwood iron in its long-established Northern markets decreased about fifty percent. The Roane Iron Company of Rockwood was forced to enter the Southern iron markets of Chattanooga, Knoxville, and other foundry

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[1]Morrow Chamberlain, A Brief History of the Pig Iron Industry of East Tennessee (Chattanooga: Morrow Chamberlain, 1942), pp. 26-27.

centers. The company found it necessary to produce low phosphorous iron similar to that produced in the Birmingham district. To do so, iron sinter of low phosphorous content was purchased from the copper companies at Copper Hill and Ducktown, Tennessee. The high freight rate on the sinter increased pig-iron costs, but for about five years, a strong market justified this practice.

The plant was forced to close by the drop in iron prices in 1930. In 1941, Tennessee Products Corporation purchased the properties and began producing ferro-manganese from manganese ores imported from South America and other foreign sources.[2]

Tennessee Products Corporation continued producing ferro-manganese until the close of World War II, at which time they went into the production of pig-iron. Except for short periods when one of the furnaces was closed for relining, both of the furnaces were in operation until 1953 when one of them was closed down. It was re-opened in 1954 and both furnaces remained in operation until October, 1957 when one of the furnaces had to be shut down. The other furnace remained in operation until April, 1958 when it too was closed. Plans were underway to reopen one of the furnaces in December, 1958. When both furnaces were in operation, the Rockwood plant produced approximately

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[2] Ibid., p. 12.

16,800 tons of pig-iron a month and employed 250 men.

All raw materials must be shipped into Rockwood. Red ore is shipped by truck from the Old Chamberlain Mine south of the Tennessee River near Kingston. Brown ore is purchased from operators in Maryville and Madisonville, Tennessee and in Missouri. Iron sinter is purchased from the Tennessee Copper Company at Copper Hill, Tennessee. Coal is mined from mines leased from the Tennessee Coal and Iron Company at Whitwell, Tennessee and coked in ovens at Chattanooga. Limestone is obtained from Crab Orchard, Tennessee. With the closing of the furnace in April, 1958 the iron mines in Tennessee were also forced to close. The freight charges on the raw materials make the cost of production of pig-iron at Rockwood high, and the plant operates at a profit only during periods of high pig-iron prices.

Four grades of pig-iron varying in phosphorous content are produced at Rockwood. Most of the high phosphorous pig-iron is shipped by rail to foundries in Chattanooga. Some small amounts are shipped to Birmingham, Nashville, Memphis, Houston, St. Louis, and other southern markets. All of the low phosphorous pig-iron is shipped to foundries in the North, with most of it going to Connecticut, Massachusetts, Ohio, and Michigan. The business recession of 1958 and the resulting decline in orders, coupled with a stock pile of approximately 40,000 tons of pig-iron, were the chief reasons for the suspension of production. About 25,000 tons of the stock pile were sold between May

and November, 1958.[3]

Copper Hill

The Tennessee Copper Company has been producing iron sinter as a by-product of its sulphuric acid production for about forty years. At present four sintering plants are in operation and about 1,600 tons of iron sinter, containing sixty-eight to sixty-nine percent iron, are being shipped out each day. Most of the iron sinter is sent by rail to the Birmingham district, with a small amount going to Rockwood.[4]

Mining Operations

The only iron mines of consequence in East Tennessee are the red ore mines near Kingston, and the brown ore mines in Maryville and Madisonville. The closing of the furnace at Rockwood forced these mines to suspend operations.

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[3]J. A. Maxwell, Vice-president, Tennessee Products Corporation, personal interview, November 12, 1958.

[4]W. E. Whitfield, Tennessee Copper Company, personal interview, November 10, 1958.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The production of iron in East Tennessee dates back to the period of early settlement. The early industry, utilizing small charcoal furnaces and easily accessible local ores, was designed to meet the needs of the early settlers. The iron works served local markets and almost every valley and cove in East Tennessee had its own furnace, forge, or bloomery. Nails, wagon tires, horseshoes, and other cast and wrought iron products were made. Although the iron industry was generally confined to local markets by the poor condition of the wagon trails and the lack of railroads, some iron was shipped by river to points as far as Natchez and New Orleans.

Following the Civil War, the iron industry in East Tennessee underwent a radical change. The numerous small charcoal-burning furnaces were replaced by a few large coke-burning furnaces. Interest shifted from the brown ores on the east side of the Valley to the red ores on the west side, and the furnaces were located near the ore deposits. A large market soon developed in the North, East, and West for the high phosphorous pig-iron of the Tennessee furnaces, and the industry reached its peak in the late nineteenth and early twentieth centuries. However, the good ore deposits in Tennessee were soon depleted, and ore had to be brought in from Alabama and Georgia. Production costs were increased and the Tennessee furnaces could

operate at a profit only during periods of high pig-iron prices. Attemps were made to produce steel and low phosphorous pig-iton in an effort to acquire Southern markets, but the Tennessee producers could not compete successfully with the Birmingham district, and these attempts proved a failure. A further loss in markets occurred when Northern iron manufacturers began putting phosphate rock in their furnace mixtures to make high phosphorous pig-iton. By 1927, there was only one furnace, the new one at Rockwood, in operation in East Tennessee. This plant was closed between 1930 and 1941, and has operated unprofitably since then.

The main cause for the failure of the iron industry in East Tennessee can be laid to the lack of suitable raw materials, principally iron. Although there were, and still are, large reserves of iron in East Tennessee (it was estimated in 1909 that there were some four hundred million tons of red ore in the Rockwood-Chattanooga-Gadsden district), most of this ore is hard ore and could not be used in the furnaces. The supplies of soft ore in Tennessee were soon depleted, and the iron manufacturers were forced to turn elsewhere for their supplies of ore. Freight charges greatly increased production costs, and Tennessee producers were unable to compete with producers in other, more favorably endowed areas.

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APPENDIX

TABLE VI

IRON ORE PRODUCTION IN TENNESSEE, 1880-1956[a]

Year	Tonnage	Year	Tonnage
1880	93,272	1918	408,954
1881-1889	Figures Unavailable	1919	283,792
1890	465,695	1920	375,538
1891	543,923	1921	8,708
1892	406,578	1922	156,464
1893	372,926	1923	267,275
1894	298,831	1924	179,853
1895	519,796	1925	164,717
1896	535,404	1926	138,819
1897	604,497	1927	121,914
1898	617,579	1928	128,928
1899	667,149	1929	102,171
1900	669,724	1930	27,710
1901	620,458	1931	8,717
1902	628,870	1932	#
1903	724,264	1933	24,912
1904	539,820	1934	3,345
1905	730,981	1935	14,219
1906	879,059	1936	27,617
1907	817,767	1937	28,359
1908	588,988	1938	13,179*
1909	648,825	1939	24,580*
1910	674,693	1940	23,187*
1911	467,356	1941-1950	#
1912	415,897	1951	35,908
1913	365,257	1952	7,990
1914	330,214	1953	18,702
1915	284,185	1954	25,363
1916	455,834	1955-1956	Figures Unavailable

[a]Sources: 1880-1913 and 1921 Annual Report of the Commissioner of Labor and Inspector of Mines (Nashville: Bureau of Labor, Statistics, and Mines). 1914-1930 The Mineral Industry (New York: McGraw-Hill Company, Inc.). 1931-1956 Minerals Yearbook (Washington: U. S. Bureau of Mines).

*Includes small production from Virginia

#No Production Reported.

TABLE VII

PIG IRON PRODUCTION, TENNESSEE 1872-1956

Year	Long Tons	Year	Long Tons
1872	42,454	1905	372,692
1873	43,134	1906	426,874
1874	48,770	1907	393,106
1875	28,311	1908	290,826
1876	24,585	1909	333,845
1877	25,940	1910	397,569
1878	28,347	1911	324,648
1879	41,475	1912	338,238
1880	70,873	1913	280,541
1881	87,406	1914	216,738
1882	137,602	1915	177,729
1883	133,963	1916	355,374
1884	134,957	1917	369,951
1885	161,191	1918	369,852
1886	199,166	1919	190,514
1887	250,344	1920	283,207
1888	267,901	1921	19,479
1889	294,655	1922	123,907
1890	299,741	1923	250,982
1891	326,747	1924	137,991
1892	300,081	1925	110,332
1893	207,915	1926	110,146
1894	217,773	1927	133,785
1895	248,129	1928 -	110,837
1896	248,388	1929	139,753
1897	272,130	1930	12,094
1898	263,439	1931	13,094
1899	346,166	1932	4,623
1900	362,190	1933	14,656
1901	337,139	1934	10,760
1902	392,778	1935-1945	*
1903	418,368	1946	31,132
1904	302,096	1947-1956	Figures Unavailable

aSources: 1872-1889 and 1930 Annual Report of the Commissioner of Labor and Inspector of Mines (Nashville: Bureau of Labor, Statistics, and Mines). 1890-1929 The Mineral Industry (New York: McGraw Hill Book Company, Inc.)1 1931-1956 Minerals Yearbook (Washington: U. S. Bureau of Mines).

*No Production Reported

TABLE VIII

BLAST FURNACE CAPACITY, TENNESSEE 1890-1948[a]

Year	Net Tons	Percent of Total South	East Tenn.	Western High Rim	Cranberry
			Thousands of Net Tons		
1890	714,560	23.12	459	205	56
1900	963,872	24.09	618	255	97
1910	798,000	17.73	457	249	92*
1920	605,136	13.14	325	240	40*
1925	370,160	9.31	?	?	?
1930	253,008	7.05	202	51	-
1940	48,720	1.35	-	49	-
1945	58,278	1.18	22	36	-
1948	73,920	1.51	34	40	-

[a]Source: H. H. Chapman, The Iron and Steel Industries of the South (University, Alabama: University of Alabama, 1953), p. 126.

*In Tennessee only.

TABLE IX

EMPLOYMENT IN IRON ORE AND PIG-IRON PRODUCTION
TENNESSEE 1889-1954[a]

Year	Iron Ore Production		Pig-Iron Production		Total Employes	Wages ($100,000)
	Number of Employes	Wages	Number of Employes	Wages		
1889	1,515	342,872	*	*	*	*
1890-1900	*	*	*	*	*	*
1901	1,223	*	*	*	*	*
1902	1,525	*	*	*	*	*
1903	1,980	511,248	*	*	*	*
1904	1,230	394,100	1,022	409,972	2,252	8.0
1905	1,407	452,391	1,900	596,200	3,307	10.4
1906	1,989	700,060	1,514	686,502	3,503	13.8
1907	2,307	772,067	1,575	763,121	3,872	15.3
1908	1,559	487,251	1,104	440,378	2,663	9.2
1909	1,629	575,781	1,393	450,312	3,022	10.2
1910	1,503	524,667	1,282	563,186	2,786	10.8
1911	996	419,635	1,012	412,226	1,008	8.3
1912	1,193	406,146	1,213	450,437	2,406	9.6
1913	1,176	353,756	1,140	358,619	2,316	7.1
1914	708	276,911	571	260,421	1,279	5.3
1915-1918	*	*	*	*	*	*
1919	592	490,275	898	648,240	1,492	10.3
1920	841	759,141	926	946,254	1,767	17.0
1921	265	*	256	80,157	521	*
1922	686	252,752	648	338,995	1,334	5.8
1923	745	492,726	1,036	727,609	1,751	11.5
1924	368	351,314	376	380,566	744	7.3
1925	207	216,921	485	367,656	695	5.8

TABLE IX (CONT'D)

EMPLOYMENT IN IRON ORE AND PIG-IRON PRODUCTION
TENNESSEE 1889-1954[a]

Year	Iron Ore Production		Pig-Iron Production		Total Employes	Wages ($100,000)
	Number of Employes	Wages	Number of Employes	Wages		
1926	220	183,325	492	269,469	712	4.5
1927	240	169,715	357	341,625	597	5.1
1928	215	171,344	194	179,453	409	3.5
1929	242	*	*	*	*	*
1930	40	24,486	305	30,618	345	.55
1931	80	*	*	*	*	*
1932	*	*	*	*	*	*
1933	85	(Includes Georgia and Virginia)				
1934	60	(Includes Georgia and Virginia)				
1935	92	(Includes Georgia, Virginia, and North Carolina)				
1936	195	(Includes Georgia, Virginia, and North Carolina)				
1937	226	(Includes Georgia, Virginia, and Mississippi)				
1938	94	(Includes Georgia and Virginia)				
1939	192	(Includes Georgia, Virginia, and Texas)				
1940	414	(Includes Georgia, Virginia, Mississippi, and Texas)				
1941-1951	*	*	*	*	*	*
1952	6	*	*	*	*	*
1953	*	*	*	*	*	*
1954	5	*	*	*	*	*

[a]Source: 1889-1930 Annual Report of the Commissioner of Labor and Inspector of Mines. Nashville: Bureau of Labor, Statistics, and Mines. 1931-1954 and 1929 Minerals Yearbook. Washington: U.S. Bureau of Mines.

*Figures unavailable.